



STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION



February 22, 2001

Ms. Lynne A. Hamjian
Connecticut State Program Unit Manager
US EPA Region I
1 Congress Street, Suite 1100
Boston, MA 02114-2023

RECEIVED

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STATE PROGRAM UNIT

Dear Ms. Hamjian:

I am please to submit Water Quality Standards revisions relating to coastal dissolved oxygen criteria. Also enclosed are the Department's Statement of Reasons (i.e. the public hearing report), an Addendum to this Statement of Reasons, and certification by the Attorney General's Office that proper legal procedures were followed. Thank you and other EPA staff for your valuable support and comments. Please do not hesitate to contact Fred Barach at 860-424-3712 if there are any questions.

Sincerely,

Robert L. Smith
Chief
Bureau of Water Management

Enclosures: Statement of Reasons (original plus 2 copies)
Addendum: Statement of Reasons (original plus 2 copies)
Proposed Water Quality Standards revisions (3 copies)
Attorney General Certification (original)

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Office of the Attorney General
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January 31, 2001

Mr. Robert L. Smith
Bureau Chief
Department of Environmental Protection
79 Elm Street
Hartford, Connecticut 06106

Dear Mr. Smith:

This is a certification by the Attorney General for the State of Connecticut that revisions to the Surface Water Quality Standards were duly adopted pursuant to state law.

Conn. Gen. Stat. § 22a-426(b) sets forth the procedural requirements for amending water quality standards. You have submitted materials which include a copy of the Notice of Public Hearing regarding the adoption of these revisions. A review of that notice shows that time, date, place, waters, and interiors which are the subject of the public hearing are set forth.

Conn. Gen. Stat. § 22a-426(b) requires publication of a notice of public hearing in the Connecticut Law Journal at least thirty days prior to the hearing and "at least twice during the thirty-day period preceding the date of the hearing in a newspaper having a general circulation in the area affected." Notice was published in the Law Journal on March 14, 2000 and was published in four newspapers of general statewide circulation on March 22 and April 19, 2000 for the public hearing held on April 20, 2000. Section 22a-426(b) also requires that "notice be given by certified mail to the chief executive office of each municipality" in the affected area, here each municipality. Return receipt cards show that the required certified mailings were made to the chief executive of each municipality.

At the public hearing on April 20, 2000, there was extensive oral testimony and written submissions made by interested persons. After reviewing the hearing examiner's report and the submissions made at the public hearing, Commissioner Arthur J. Rocque, Department of Environmental Protection, is ready to authorize the revisions to the Surface Water Quality Standards of the State.

In addition, upon acceptance by the Federal Government of this revision to the Surface Water Quality Standards of the State, notice shall be published in the Connecticut Law Journal as required by Conn. Gen. Stat. § 22a-426(c).

Mr. Robert Smith
January 31, 2001
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In summary, it is our opinion that the adoption of the revision to the Surface Water Quality Standards of the State was duly undertaken pursuant to state law, and we so certify.

Very truly yours,

A handwritten signature in blue ink, appearing to read "Richard F. Webb", is written over the typed name.

Richard F. Webb
Assistant Attorney General

RFW/bjg

STATEMENT OF REASONS
CONNECTICUT WATER QUALITY STANDARDS
REVISIONS CONCERNING COASTAL DISSOLVED OXYGEN CRITERIA
HEARING DATE: APRIL 20, 2000

On March 14, 2000 the Commissioner of the Department of Environmental Protection (Department) published a notice of intent to revise Connecticut Water Quality Standards in the Connecticut Law Journal (Exhibit 10). Legal Notices were also published twice in Connecticut's five largest newspapers (Exhibit 3). All Connecticut municipalities were sent, via certified mail (Exhibits 11 and 12), the same notice, an information package, and a copy of the Department's proposed revisions of the Water Quality Standards. Pursuant to such notices, a public hearing was held on April 20, 2000 at the Department in the Russell Hearing Room.

The Public Hearing commenced at 9:35 a.m. Mr. Fred Banach (Hearing Officer) reviewed the hearing format and the statutory decision making process (Section 22a-426, Connecticut General Statutes). Mr. Banach briefly summarized the major revisions proposed by the Department and noted that the hearing record would remain open to receive written testimony until May 31, 2000.

Speakers and a summary of their oral testimony are presented below:

Ms. Jeanne Voorhees, USEPA New England, Connecticut Unit Team: Ms. Voorhees read from a prepared statement (Exhibit 4) and noted that EPA supported many of the proposed changes and will provide detailed comments by May 31, 2000.

Mr. David Galt, Office of the Soundkeeper: Mr. Galt read from a prepared statement (Exhibit 8) signed by Mr. Terry Backer, Soundkeeper. The statement included detailed comments concerning the proposed marine dissolved oxygen criteria revisions. The Soundkeeper recommended higher dissolved oxygen criteria be adopted than proposed. He also expressed concern regarding the water quality monitoring interval necessary to verify attainment of the proposed dissolved oxygen criteria.

Ms. Carolyn Hughes, Connecticut Chapter of the National Audubon Society: Ms. Hughes supported the proposed marine dissolved oxygen criteria revisions in that the revisions were consistent with field and laboratory research of both the Department and the Environmental Protection Agency (EPA) and that the proposed criteria would fully protect marine life.

List of Exhibits

1. Authorization to hold the Public Hearing.
2. Proposed Revisions to the Surface Water Quality Standards (April, 2000)
3. Copies of the Legal Notices sent to The Connecticut Law Journal, Connecticut Post, Hartford Courant, New Haven Register, Norwich Bulletin, and Waterbury American.
4. EPA New England letter dated April 10, 2000. (EPA)
5. Letter dated April 13, 2000 from Robert Rostkowski, City of Bristol. (Bristol)

6. Memo dated April 11, 2000 from Robert Gilmore, DEPARTMENT, Inland Water Resources Division (IWRD)
7. Memo dated April 7, 2000 from Lee Dunbar, DEPARTMENT, Planning & Standards Division (DBAR)
8. Comments dated April 20, 2000 from Terry Backer, Soundkeeper. (SK)
9. Letter dated April 20, 2000 from Gary Ginsberg, PhD, Department of Public Health, Environmental Epidemiology & Occupational Health. (DPH)
10. Copy of Legal Notice published in the Connecticut Law Journal, March 14, 2000.
11. Information package sent certified mail by the Department to all Connecticut municipalities.
12. Certified Mail return receipts from municipalities
13. Fact Sheet concerning the Proposed Surface Water Quality Standards revisions.
14. Letter dated May 31, 2000 from Robert Taylor, Loureiro Engineering Associates, Inc. (RBT)
15. Letter dated May 31, 2000 from Robert Dusza Jr., Connecticut Water Pollution Abatement Association, NPDES Subcommittee (CWPA)
16. Letter dated May 26, 2000 from Lynne Hamjian, USEPA, Connecticut State Program Unit, requesting hearing record extension to receive written comments.
17. Letter dated May 23, 2000 from Howard Golub, Interstate Sanitation Commission, requesting hearing record extension to receive written comments.
18. Memo dated May 26, 2000 from the Hearing Officer noting the hearing record would be kept open to receive written comments until June 16, 2000.
19. Letter dated June 15, 2000 from Howard Golub, Interstate Sanitation Commission (ISC).
20. Letter dated June 16, 2000 from Linda Murphy, USEPA Office of Ecosystem Protection with three enclosures providing additional comments from the EPA New England (EPA); the US Fish and Wildlife Service, New England Field Office (FWS); and the National Oceanic and Atmospheric Administration, National Marine Fisheries, Northeast Region (NMF).

Responsiveness Section

Comments relating to the proposed coastal dissolved oxygen criteria revisions are presented and discussed below. Many comments have been paraphrased for brevity and similar comments may be combined. Each comment is followed by an acronym that identifies the origin of the comment. The **List of Exhibits** associates the acronyms with the commenting agency or individual. Comments are followed by the Department's response, including when appropriate, references to the changes to be made as a result of the comment. All written comments, as originally provided, are part of the public hearing record and are available for review upon request.

Several of the comments indirectly suggest the proposed dissolved oxygen (DO) criteria will lead to poorer water quality in Long Island Sound. Other comments questioned both the science and advisability of altering the existing coastal DO criteria. As a general response, the proposed DO revisions are associated with a major program to improve the quality of Long Island Sound and scientific evidence supports the need to modify the existing DO criteria for offshore Class SA and class SB waters. The existing criteria were based on the "best available" information at the time they were adopted, roughly three decades ago. Estuarine systems are very susceptible to natural declines in oxygen levels during the summer. Computer model simulations suggest that even during pre-colonial times, DO levels in the bottom waters of western Long Island Sound may have fallen well below the existing criteria.

There is no question that oxygen levels today fall well below the proposed coastal DO criteria in parts of Long Island Sound during the summer. Attainment of the proposed criteria would represent a significant improvement in the quality of Long Island Sound and the health of the Sound's resident organisms. EPA marine DO research, some of which was done using Long Island Sound information, provides a solid, scientific foundation for Connecticut's proposed coastal DO criteria. The criteria, when adopted, will be protective of Long Island Sound resources, will help direct the combined management efforts of Connecticut and New York towards a healthier Long Island Sound, and provide a valid basis for measuring progress. Finally, monitoring and research will continue in Long Island Sound and, just as progress towards meeting environmental goals will be carefully measured and the management approach periodically re-assessed, so will be these DO criteria. If and when additional research documents a need to further refine these coastal DO criteria, there will be ample opportunity to reopen public consideration of these criteria.

Definitions

Comment: Why delete the reference to the rise and fall of the tide in the definition of **coastal and marine waters** as a means of differentiating coastal and marine waters from inland waters? Coastal waters are commonly understood to mean saline waters adjacent to the coast. The definition in Section 22a-93, CGS merely narrows the definition with respect to the salinity concentration. Functionally coastal waters have often been affected by manmade structures such as roads, culverts and tide gates that limit or preclude tidal flushing. The use of tidal influence as a means of differentiating coastal and marine waters from inland waters does have programmatic value. Without question it simplifies the task of mapping the various waters of the state or portions thereof. (RBT)

Response: The definition in Section 22a-93 was used intentionally to narrow coastal and marine waters to water having salinity concentrations indicative of having a direct connection to Long Island Sound. The definition was modified to recognize that tidally influenced, freshwater river systems (e.g. the Connecticut River between Essex and Windsor) are subject to freshwater criteria, not criteria adopted for salt water resources.

Comment: "Marine waters" are not defined in Section 22a-93. They are commonly understood to mean waters usable in marine navigation and they have also often been functionally limited by manmade structures such as dams or locks. (RBT)

Response: Point noted. The definition of **coastal and marine waters** will be revised to include the statutory definition of "coastal waters". Further, "coastal and marine waters" will be changed to "**coastal waters**" throughout the text.

Comment: In the proposed definition of **nearshore** and **offshore** waters, the nearshore waters include embayments and harbors. What criteria would apply to an embayment or harbor that is greater than 5 meters in depth? Would it be the criteria for the sub-pycnocline offshore waters or would the 6 mg/l at any time criterion hold no matter what the depth is because it is nearshore water? (ISC)

Response: Embayments and harbors are considered nearshore waters regardless of depth.

Comment: A better definition of **nearshore** would be "coastal waters that are generally less than 5 meters in depth". It is also noted that nearshore waters are defined in Section 22a-93 of the Connecticut General Statutes by reference to the

10-meter contour below mean high water. Is the difference in the definitions intentional? Similarly, a better definition for **offshore** would be "coastal waters that are generally greater than 5 meters in depth". "Offshore waters" are also defined in Section 22a-93 using the same reference contour used in the definition of "nearshore waters". (RBT)

Response: The difference in depth contour noted is intentional. The suggestion to substitute "coastal" for "surface" in both definitions will be made.

Comment: The proposed definition of **pycnocline** refers to "a steep density gradient in an estuary cause (sic) by difference (sic) in temperature or salinity between the bottom and surface layers of water that limits mixing of the two layers." As defined by US EPA's database, STORET, version 1.1, the pycnocline is "a range of water depth where there is an increase in water density due to a combination of decreasing temperature and increasing salinity." The US EPA definition indicates that the pycnocline is a portion of the water column that has a width (or a depth) associated with it. The differences in the two definitions should be addressed. (ISC)

Response: The comment would appear to reflect a concern regarding the criteria for pycnoclinic water which is addressed in the next section of this response document. The word gradient" implies a range of depth. The definition need not be modified, although the editing mistakes that were pointed out will be corrected.

Proposed Marine Dissolved Oxygen Criteria Revisions

Comment: The Department is commended for proposing revisions using the approach outlined in EPA's *Draft Ambient Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras (January 2000)* into the WQS. The draft criteria are based on a biological framework that integrates time and establishes separate criteria for different life stages (larvae versus juveniles and adults). The recommendations are intended to represent the best current estimates, based on available data, of dissolved oxygen (DO) concentrations necessary to protect saltwater aquatic life in the Virginia Province. However, it may yet be revised. (ISC, EPA)

Response: The Department is aware of the status of the US EPA draft guidance including the fact that EPA's Scientific Advisory Board has reviewed it without recommending major changes. Nevertheless, there is some uncertainty, and the Department is receptive to reviewing any subsequent changes to the draft DO criteria and revisit the DO criteria for Long Island Sound in the future. It is also worthy to note that the Department's proposed DO criteria incorporate a margin of safety above the minimum, potentially allowable DO concentration reported in EPA's draft criteria document. While the US EPA draft guidance suggests oxygen levels as low as 2.3 mg/l may be acceptable for short periods of time, the Department has proposed a DO concentration no lower than 3.5 mg/l.

Comment: To avoid confusion it is suggested that the criteria for SA offshore waters be grouped as is done in presentation of the SB DO criteria. As drafted, the criteria for SA offshore waters are divided by presentation of the nearshore requirements. (EPA)

Response: The presentation format for Class SA and Class SB DO criteria was modified to improve clarity and consistency.

Comment: The proposed criteria for Class SA and SB include the statement: "Cumulative periods of dissolved oxygen in the 3.5 - 4.8 mg/l range should not exceed exposure parameters detailed in Appendix E." To prevent acceptance of exposure scenarios that are not protective, replace "should" with "shall". (EPA)

Response: The suggested change has been made.

Comment: What criteria are proposed for the parts of the water column within the pycnocline itself? Is it the 6.0 mg/l or is it the lesser values being proposed? One way to address this might be to say that the 6.0 mg/l applies to waters above the pycnocline and the other values apply to the waters within and below the pycnocline. (ISC)

Response: The pycnocline, which represents a thin slice of water with respect to the depth of the entire water column, has been grouped with the bottom waters as suggested.

Comment: Has the Department proposed lowering the use classifications for any of the waters of Long Island Sound and its embayments and harbors to which these new proposed dissolved oxygen criteria would apply. (ISC)

Response: No site specific designated use or classification changes are proposed.

Comment: The Long Island Sound Study (LISS) Comprehensive Conservation and Management Plan (CCMP), Section VII, Management and Conservation of Living Resources and Their Habitats, page 103, states that "Laboratory tests conducted for the LISS show that the most severe effects occur when dissolved oxygen falls below 1.5 mg/l in the short term and 3.5 mg/l over a longer period, but that there are probably mild effects of hypoxia when dissolved oxygen falls below 5 mg/l." Based on this, it seems that the proposed revisions may not be protective to all species in Long Island Sound. (ISC)

Response: The LISS preliminary DO targets pre-date the EPA DO criteria document. In short, they are no longer best science and are superceded by the draft EPA document.

Comment: Based on the analysis of the proposed sub-pycnocline DO standards within the 4.8 and 3.5 mg/l range, there are concerns about the ability of these limitations to protect aquatic organisms on a long-term basis. The Department proposes to adopt standards with a provision for the duration of DO concentrations. A method that possibly incorporates moving averages of DO concentration should be considered and further evaluated. This is substantiated in the Comprehensive Conservation and Management Plan (1994) for the Long Island Sound Study, page 26, sidebar #5 entitled "Interim Targets for Dissolved Oxygen" which recommends interim targets for dissolved oxygen below the pycnocline as:

"1- for each area, with a dissolved oxygen minimum of 5 mg/l ... - maintain or enhance current levels.
2- for each area with a dissolved oxygen minimum of 3.5 mg/l and above - achieve a four-day average of 5 mg/l.
3- for each area with a dissolved oxygen minimum of below 3.5 mg/l- achieve at least a four-day average of 3.5 mg/l to minimize sublethal effects..."
Sidebar #5, footnote #5 states, "The average dissolved oxygen concentration should be calculated as moving averages, using true daily means derived from continuous records... The LISS has decided to adopt an averaging period of four days. This is

important to reduce the probability of prolonged exposures to near minimum dissolved oxygen conditions.” (ISC)

Response: Again, research to support development of the draft EPA DO criteria document supercedes that of the Comprehensive Conservation and Management Plan (1994) for the Long Island Sound Study in terms of DO criteria.

Comment: In the EPA draft DO criteria document, the section “Application of Persistent Exposure Criteria” (p. 22) states, “The current recruitment model is a first attempt at providing a method that incorporates duration of exposure in the derivation of DO criteria. A model that could integrate gradual change in daily DO concentrations is desirable.” Has specific Long Island Sound data been used in the development of these criteria? If not, this should be considered. (ISC)

Response: Research for the EPA draft DO criteria document was initiated on behalf of the Long Island Sound Study (LISS) and began with Long Island Sound (LIS) relevant species. EPA was able to expand the research to include relevant species and application throughout the Virginian province. Clearly, LIS data were central to the development of the draft EPA DO criteria document.

Comment: It is stated in the EPA draft DO document Introduction and in Appendix E that prior to deriving conclusions using the model in the draft guidance that the model should be verified and calibrated incorporating regional data. Has the Department retrieved and used existing databases from ambient water quality monitoring studies in Long Island Sound to verify and calibrate the model? (ISC)

Response: No. The draft EPA DO criteria were developed with a strong Long Island Sound foundation and are conservatively drawn in EPA’s draft criteria document as well as in Connecticut’s proposal. Recalibrating the EPA model with regional or local data would be a necessary exercise only if lower (or less conservative) DO criteria were proposed. This is not the case with Connecticut’s proposal. (Note, see also the Addendum to this Statement of Reasons which explains that the EPA’s final DO criteria document, which the Department used in the final revised coastal DO proposal to EPA, is more protective of sensitive geographic conditions).

Comment: The phrase “alternative DO standards” in the first sentence of the first paragraph in Appendix E. could create confusion, i.e., it could be read to suggest alternatives to the criteria presented for Class SA and SB for the sub-pycnocline offshore waters. The following revision is suggested: “~~Alternative DO standards~~ would Criteria different from the 6.0 mg/l and 5.0 mg/l minimums for Class SA and SB waters, respectively, apply only to the sub-pycnocline...” (EPA)

Response: The suggested change has been made.

Comment: The Department has chosen to propose a minimum DO criterion for the sub-pycnocline offshore waters of 3.5 mg/l rather than 2.3 mg/l. However, Appendix E includes a sentence identifying 2.3 mg/l as the minimum level consistent with resource protection. To avoid confusion, and to be consistent with its proposed criteria, the Department should change “2.3 mg/l” to “3.5 mg/l” in the sixth sentence of the second paragraph. If the Department wishes to retain reference to 2.3 mg/l for comparison with EPA’s guidance, a more detailed discussion distinguishing between the 2.3 mg/l from EPA’s draft guidance and the Department’s selection of 3.5 mg/l as a criterion for Connecticut’s marine waters should be included. (EPA)

Response: The reference to EPA's draft criteria guidance has been modified to better relate the 2.3 mg/l criterion to EPA's research. The transition to the more stringent Department proposal (i.e. the 3.5 mg/l criterion) is now clearer.

Comment: It would be useful to include the following statement as an introduction to the Marine DO Criteria Appendix: "Marine DO criteria are intended to protect three aspects of biological health: juvenile and adult survival, growth and larval recruitment. Marine DO criteria will provide a basis for establishing appropriate total maximum daily loads (TMDLs) in Long Island Sound for nutrient control, discharge limits in the NPDES permits, appropriate nonpoint source controls, and other water resource management efforts. The intention of the marine DO criteria is consistent with EPA's *Draft Ambient Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras (January 2000)*." (EPA)

Response: Although the appendix was intended to be brief, a statement has been inserted referencing EPA's draft DO criteria document.

Comment: The following revisions to the proposed language in Appendix E. are suggested to clarify how protection of juvenile and adult survival, growth, and larval recruitment is achieved:

a) Protective Goal for Growth:

The third sentence in the second paragraph on page 49 should be changed as follows: "A DO concentration of 4.8 mg/l would meet the chronic criterion for growth and protect estuarine organisms resident in LIS regardless of duration."

b) Protective Goal for Juvenile and Adult Survival:

The sixth sentence in the second paragraph on page 49 should be changed and a sentence should be added as follows: "The minimum DO level, or the level below which there would be no exposure period consistent with resource protection, is 2-3 3.5 mg/l." The acute criterion of 3.5 mg/l is the protective goal for juvenile and adult survival.

c) Protective Goal for Larval Recruitment:

The last sentence of the last paragraph on page 49 should be revised as follow: "...resource protection goals are maintained for larval recruitment." (EPA)

Response: The suggested edits for a) and c) have been made. The clarification suggested in b) was previously addressed.

Comment: The title for Table 1, page 49, should be revised as follows: "...sub-pycnocline waters to ensure the protection of larval recruitment." (EPA)

Response: The table caption has been modified to refer to the "area affected" since "sub-pycnocline" no longer applies. The "area affected" includes both waters in the pycnocline and the sub-pycnocline.

Comment: The statement appearing in Appendix E. that: "Similar exposure allowances were calculated in an EPA model for each 0.5 mg/l increment (Table 1)", should be deleted. This statement leads the reader to believe that the Department generated Table 1 based on its own field data and model runs, when, in fact, the proposed table was developed based on a simple revision of Table 3 appearing on page 24 of EPA's draft document. Furthermore, EPA's Table 3 is based on a hypothetical situation. (EPA)

Response: The referenced sentence has been modified to clarify that the data are EPA's and it is the interpretation of those data by the Department that leads to a more stringent level of protection.

Comment: The proposed DO revisions raise concerns. The overview of the approach is outlined on pages 10 and 11 of the EPA draft guidance. The method incorporated establishes a criterion of 2.27 mg/l for juvenile and adult survival on page 12, and a criterion of 5 mg/l for larvae growth on page 17. Further analysis of the effect of persistent exposure to low DO concentrations to larval recruitment on page 22 states that the "Interpretation of acceptable hypoxic conditions when the DO values are between the juvenile survival and larval growth limits depends on the characterization of the duration of hypoxia." Using these criteria for DO standards seems inconsistent with the scientific data that DO levels below 5 mg/l cause stress and endanger larval growth for several species. This is clearly indicated at the top of page 17 which states that "The final protective value for growth is 4.8 mg DO per liter, but would increase only to 5.0 mg/l if the number of genera was kept at 11." Based on this statement, the proposed limits within that range should be reconsidered. (ISC)

Response: In cases of persistent low DO exposure, such as occur in offshore Long Island Sound, the EPA approach attempts to interpret "...acceptable hypoxic conditions when the DO values are between the juvenile survival and larval growth limits [which] depends on the characterization of the duration of hypoxia..." (p. 22). While this approach is protective of larval survival, according to the EPA draft document, there will still be some effects on growth of sensitive species. However, the draft EPA DO criteria document points out "Although it is generally accepted that reduced growth means reduced overall fitness, there is little direct evidence for this in the field." (Pp. 17-18). Further, because of uncertain impacts on growth, the EPA document suggests, "As an alternative to the growth criterion, a criterion that addresses chronic stresses from long-term or short-term exposures to low DO can be based on larval recruitment effects." (p. 18). The larval recruitment model developed by EPA for the Say mud crab (p. 22) was used to formulate the Department's DO criteria proposal for persistent exposure conditions (Note, see also the Addendum to this Statement of Reasons which explains that the EPA's final DO criteria document strengthened the appropriateness of using a larval recruitment model). In response to other comments, Appendix E has been modified to improve clarity, however, interested readers should refer to the EPA draft document for complete details.

Comment: It is stated in the Introduction of the US EPA draft guidance, page 7, that "the document does not address direct behavioral responses (i.e., avoiding low DO) or the ecological consequences of behavioral responses such as changes in predation rates or in community structures." Has the Department made any efforts to research and evaluate the aforementioned behavioral responses and ecological consequences in Long Island Sound? If so, what analyses on this particular subject can be presented as supportive of the proposed revisions? (ISC)

Response: The Department's Marine Fisheries surveys have adequately demonstrated typical behavioral avoidance of several adult finfish and crustacean species in LIS. This research has been subject of many discussions with the Living Marine Resources Work Group of the Long Island Sound Study and has been published in a peer-reviewed journal. That work shows no measurable avoidance effect at DO concentrations above the proposed 3.5 mg/l threshold DO criteria. Changes in predation rates or community structure have not been predicted, and have rarely been used to support the adoption of any criteria because of the difficulty in making those measurements in the field.

Comment: Are there specific physical, biological or chemical conditions that are unique to Long Island Sound that may not be applicable to the general Virginia Province for which the [EPA DO] model was developed? (ISC)

Response: Every estuary is unique, but the above referenced model, and the Department's conservative application of it, is not likely to jeopardize any conditions unique to LIS (Note, see also the Addendum to this Statement of Reasons which explains that the EPA's final DO criteria document, which the Department used in the final revised coastal DO proposal to EPA, is more protective of sensitive geographic conditions).

Comment: A criteria of 4.2 mg/l DO below the pycnocline for a maximum 7 days, with an interim criteria of 3.5 mg/l to be achieved within 15 years is recommended. This time period is consistent with the interim goal of the TMDL for nitrogen. The 4.2 mg/l criteria will provide a reasonable margin of safety to account for the negative compounding impact of other environmental disturbances related to low DO. (SK)

Response: This comment proposes a more conservative interpretation than the Department has proposed, but does present it as future criteria, to be attained in 15 years, concurrent with implementation of the proposed plans to improve water quality on LIS. In the interim, the EPA proposed marine criteria would be used. To avoid confusion over what criteria to use, the Department proposes to adopt the criteria as proposed and at a future time, if warranted by science, adopting a different criteria (see also comment below). Connecticut Water Quality Standards are subject to the triennial review requirements of the Federal Clean Water Act, which provides ample opportunity for making revisions if justified by better science.

Comment: A minimum 3.5 mg/l DO level for a maximum of 7 days appears to be protective of all life stages of marine life that were examined in the Narragansett Study, assuming all other environmental factors are optimal. The Narragansett Study shows there is growth impairment in some oxygen-sensitive species below 4.2 mg/l, and a few of the laboratory test runs showed mortality below that level. The Study results show that, all else being equal (that is, no other major environmental stressor is acting in combination with low DO), no harm will come to any life stage of an organism (larvae, juvenile, adult stages) that is exposed to 3.5 mg/l for 7 days and is then re-exposed to higher oxygen levels. A DO of 3.5 mg/l will, however, cause oxygen-sensitive larval stages of some species (Say mud crab, Atlantic silverside, lobster, longnose spider crab) to reduce growth rates for the duration of low DO exposure in order to put more energy into respiration. (SK)

Response: This comment is essentially correct, except the period of exposure to various DO concentrations that impairs growth is not detailed and growth impairment above 4.2 mg/l was observed in the draft EPA DO criteria document. The growth criterion of 4.8 mg/l is for a chronic, continuous exposure. The approach proposed by the Department applies the relationship developed by EPA between DO concentration and period of exposure. The rationale is addressed in the response to an earlier comment as interpreted from the EPA draft marine criteria document.

Comment: We are concerned about two issues that were not resolved by the Narragansett Study. One is larval growth. If larval growth is delayed, they may be exposed to longer periods of predation. This is a secondary effect of low oxygen. The other issue is avoidance by fish from areas of low oxygen. The Department counted over one million fish, crustaceans, and other organisms over several seasons of trawl studies to determine avoidance behavior of those organisms to various low DO levels. Avoidance was very low at 3.5 mg/l DO (about 5% of the total biomass was missing compared to trawl counts at 5 mg/l DO) but increased rapidly

as oxygen levels fell below that threshold. The biological effects of avoidance are unclear, but fishing is a designated use of the Sound and fishermen may be affected. The 4.2 mg/l standard would provide a safety margin for growth and avoidance problems. (SK)

Response: This comment is similar to an earlier comment questioning the adequacy of the science EPA used to develop the draft criteria document. These comments should be directed to EPA's scientific review committee. If the authors agree with these concerns, the criteria document should be revised accordingly and the Department can then amend the DO criteria proposal on the basis of new information.

Comment: The existing DO criteria for Long Island Sound is "not less than 6 mg/l at any time." New York State has adopted a 5 mg/l criterion. The Department acknowledged that the 6 mg/l standard was based on information for protection of fresh, not marine waters (October 1999 TMDL Document). The proposed TMDL for Long Island Sound did not use the 6 mg/l standard for developing the load reduction requirements but instead used the New York State DO standard of 5 mg/l. A review of the underlying science behind these standards (5.0 mg/l (New York), 6.0 mg/l (Connecticut) confirms that these WQS are clearly chronic, not acute water quality criteria even though "never less than at any time" language qualifies the application of the criteria. (CWPA)

Response: The proposed LIS Nitrogen TMDL used existing DO criteria for both Connecticut and New York. The existing Connecticut coastal water DO criteria (i.e. 6 mg/l) is being retained for certain nearshore coastal waters, as well as some offshore coastal waters such as certain waters above the seasonal pycnocline. Simply modifying the criteria because it may be too high, especially when attainment of this criteria has not identified as problematic is contrary to federal regulations governing state Water Quality Standards and lowering of water quality criteria. Nevertheless, similar to previous comments questioning whether the proposed coastal DO criteria revisions are not protective enough, there will be ample opportunity during the 15 year TMDL implementation schedule for improving LIS to reassess the 6 mg/l DO criteria. Modifying the DO criteria to 5 mg/l, in absence of more thorough analysis and justification, is not appropriate and could not be approved by EPA.

Comment: The Department has stated that the existing DO criteria is outdated and not supported by the latest scientific information on DO needs for marine organisms, which was specifically developed to address conditions in Long Island Sound (see, USEPA 1999 Marine DO Criteria). Appendix E presents the Department's interpretation of the 1999 Marine DO Criteria, concluding the following:

- A DO concentration of 4.8 mg/l would protect estuarine organisms in LIS regardless of duration.
- DO levels may remain between 4.8 - 4.3 for "24 days or less.
- DO levels may remain between 3.5 and 3.8 for " 7 days of exposure.
- The minimum DO level or the level below which there would be no exposure period consistent with resource protection, is 2.3 mg/l.

A comparison of the existing and proposed DO criteria to the acceptable DO levels specified in Appendix E confirms that Department's proposed action is plainly inconsistent with the latest EPA science which determined that a much longer averaging period (30 days) applies to DO criteria in 5 and 6 mg/l range and the minimum DO level should be 2.3 mg/l not 3.5 mg/l. See also the 1986 EPA Freshwater DO criteria document. The 6 mg/l DO criteria should be modified to be consistent with the NYS DO standard of 5 mg/l based upon the Department's conclusion that 4.8 mg/l chronic (continuous exposure) criteria is protective of fishery

resources in LIS, particularly since the TMDL used the 5 mg/l DO level as the acceptable long term exposure water quality objective. Thus, the correct marine DO standard for chronic exposure should be a 5.0 mg/l 30 day average, not "never less than 6.0 mg/l at any time." There is no basis in science to continue to maintain the 6 mg/l standard and pursuant to Section 103 of the Clean Water Act, a consistent water quality objective needs to be established for this interstate water body. Setting the minimum DO criteria as "not less than 3.5mg/l" is plainly inconsistent with the Department's conclusion that the minimum short-term exposure criteria (hour or less) is 2.3 mg/l. DO levels may drop below 3.5 mg/l for short periods and not cause adverse fishery impacts based on the latest information contained in EPA draft DO criteria document. It would seem both reasonable and protective to set the absolute minimum DO at 3.0 mg/l. (CWPAAs)

Response: The laws and regulations governing adoption of State Water Quality Standards are not guided by a principal of adopting the most minimally protective criteria potentially allowed. Indeed there are very stringent Antidegradation requirements in federal regulations that suggest the opposite. The Department believes the proposal is both consistent with the draft EPA marine DO criteria document and scientific investigations of Long Island Sound resources. The Department is the first state in the northeast to evaluate EPA's research, develop an adaptation for use in Connecticut waters, and propose major revisions for coastal DO criteria. Similar to responses previously provided, these DO criteria will be periodically revisited in the future as progress is made towards implementing the LIS Nitrogen TMDL Analysis. During this period monitoring will continue and the science of LIS DO dynamics and corresponding organism responses will improve. This will help guide future consideration of this concern.

Comment: The DO criteria are missing an appropriate frequency of exceedance to ensure proper application of the criteria. The Department has adopted EPA's recommended once in three year return exceedance frequency for applying other chronic and acute criteria. (See Appendix D, footnote 2 and 3). It is apparent that the relevant DO criteria should not be applied to as "never to exceed at any time values" as the underlying science identified the acceptable frequency and magnitude of water quality to protect fishery resources. For over 15 years, EPA has asserted that exceeding water quality objectives (acute and chronic) on a once in three year return interval provides a "high degree of protection." See, 1991 Technical Support Document for Water Quality-based Toxics Control; 1992 National Toxics Rule; 1998 Draft California Toxics Rule; 1997 Great Lakes Initiative; and 1998 EPA Water Quality Standards Handbook (2nd Ed.). The Department's failure to update the DO criteria to reflect this scientific conclusion was arbitrary and capricious. (CWPAAs)

Response: The reference to frequency of exceedance once in three years refers to toxic substance criteria and does not apply to DO standards.

Comment: The Department's own analysis of the most recent scientific information on DO needs for Long Island Sound, the proposed WQS are unduly restrictive. Incorrect magnitude (e.g., 6 vs. 5 mg/l), duration (never less than at any time vs. 30 day average) and frequency of occurrence (never less than at any time vs. once in three years) are established in the proposed rule. Consequently, the proposed DO objectives will continue to inappropriately identify marine waters as impaired triggering the need for unduly restrictive nutrient reduction requirements. The failure of the Department to revise the DO criteria to reflect the latest scientific information will impose severe economic harm on communities and cost hundreds of millions of dollars statewide beyond that necessary to ensure appropriate environmental protection. The Department, consistent with the administrative record, needs to

revise the existing DO standards to accurately reflect the latest available scientific information. (CWPA)

Response: This comment has been previously addressed in prior responses. The Department's proposed DO criteria are a fair and careful interpretation of the latest and best scientific information available and are not unduly restrictive. While a small margin of safety was applied to the larval survival curve, it was done to lessen impacts on larval growth, which may require DO levels as high as 4.8 mg/l. With respect to the existing 6 mg/l DO criteria, the implication that nutrient removal will be greater as a result of retaining in part this criteria, than it would be to attain the proposed coastal DO criteria for offshore waters in and below the pycnocline, is highly speculative. The Department's water quality monitoring demonstrates that most of Long Island Sound surface waters presently already achieves this criteria. The suggestion that severe economic harm on communities will result is without merit.

Comment: The proposed DO criteria for offshore waters are not less than 3.5 mg/l below the seasonal pycnocline. Cumulative periods of DO in the 3.5-4.8 mg/l range should not exceed exposure parameters detailed in Appendix E. These proposed criteria are based on the recent EPA draft publication on dissolved oxygen for the mid Atlantic coast region including Long Island Sound. The exposure period when DO is in the 3.5-4.8 mg/l range as referenced in Appendix E is intended to protect larval populations from greater than a 5% loss or mortality. The exposure criteria do not provide a level of protection that ensures 100% survival of larval populations, some acute (lethal) effects are allowed. In addition, this larval mortality criterion does not protect larvae from chronic effects such as growth impairment since an allowance for chronic growth effect is included in variable 3 of the model. In a somewhat similar fashion, the DO criterion continuous concentration of 4.8 mg/l is intended to protect the larval growth stage of most fish and invertebrate species from sub-lethal effects. It does not ensure that all species would be protected from chronic effects of DO concentrations that would limit or otherwise adversely effect growth. Consequently, the proposal to lower the DO criteria is not consistent with Standards #12 & 14 which regulate surface waters to ensure that discharges do not cause acute or chronic toxicity or impair aquatic life. According to the EPA report, a DO concentration of 4.8 mg/l must be maintained to prevent chronic effects such as growth impairment in most species. Species that are more sensitive would not be protected even with the 4.8 mg/l criteria. In order for Connecticut to adopt a DO criterion less than 5 mg/l, additional research would need to be conducted by EPA investigators to integrate the larval growth and larval survival curves on Figure 7, page 23 of the draft D.O. document. This additional data is required to develop a single DO curve that protects 95% of aquatic species from adverse effects of low DO on larval growth and larval survival simultaneously. Consequently, the existing DO standard should be retained in SA waters or alternatively, adopt the SB criterion of 5 mg/l below the seasonal pycnocline to more or less maintain the status quo. (FWS)

Response: Standard 12 is not relevant in regards to these proposed DO criteria as it relates to the discharge of wastewater with potentially toxic pollutants identified in Appendix D. Standard 14 addresses chemical constituents in surface water and sediment and must also be read in context of Standard 8 which acknowledges that natural conditions can alter water quality conditions to something less than ideal. For example, extensive monitoring and subsequent modeling of LIS very strongly suggests that during the pre-colonial era, DO levels below the pycnocline in Long Island Sound may have dropped to as low as 3.5 mg/l. The recommendation to maintain "status quo" ignores the scientific knowledge of Long Island Sound DO dynamics gained by more than 15 years of extensive research, monitoring and modeling. Maintaining status quo also ignores the existence of EPA's substantial

marine DO research. Connecticut's existing (coastal) DO criteria are clearly flawed and should be revised to reflect better science. Further, the existing criteria are of little value for managing dissolved oxygen in the bottom waters of LIS, and a potential legal hindrance to adopting the Long Island Sound Total Maximum Daily Load Analysis and the subsequent wasteload allocations for dischargers.

Comment: The pycnocline is constantly in flux. That is, the top, the bottom and the width of the pycnocline are constantly changing. How will this be determined as to where it starts, where it ends and how wide it is? (ISC)

Response: The dimensions of the pycnocline will be measured by monitoring water quality. Nature will determine if there is a pycnocline and how deep it is and how sharp the density gradient is. The recommend change to include pycnocline depth with bottom waters should resolve this concern.

Comment: How will it be determined when the seasonal pycnocline forms and when it ends? If a climatic event occurs during the summer that promotes mixing throughout the water column, will the DO standard revert to the "6.0 mg/l at any time?" If a severe storm condition occurs early in the summer season, the pycnocline may recur. What type of constant monitoring will be in place to determine this? (ISC)

Response: If no pycnocline is formed, the surface water criterion prevails. Bi-weekly monitoring during the summer is planned and conditions interpolated for the periods between monitoring events. There is no question that when a pycnocline is disrupted in early summer it will often reform when conditions settle.

Comment: The in situ measurement and monitoring of a variable standard, such as is being proposed, and the determination of whether the waters are meeting that standard is much more difficult than an "at any time" standard as presently exists. Does Connecticut have a plan in place or proposed that will determine when the pycnocline starts and ends seasonally; how deep the pycnocline is; where it starts in the water column; where it ends in the water column; and the width of the pycnocline? It seems that this will require a continuous type of monitoring, possibly with remote instrumentation to enable one to determine whether these waters are meeting the proposed criteria. Does Connecticut have a monitoring plan in place? If not, it should seriously consider devising a program during the adoption process of the proposed criteria, rather than waiting until after adoption. A continuous ambient remote automatic monitoring system is expensive and labor intensive. This should be coordinated with the others who have jurisdiction within the Sound in order to get a comprehensive Sound-wide picture and should not be limited to the Connecticut portion of the Sound. (ISC)

Response: While continuous remote automatic monitoring would be ideal, and the deployment of monitoring buoys throughout the Sound superb, the Department proposes a more practical approach of bi-weekly monitoring during the warmer months to track pycnocline dynamics and then use Long Island Sound models to help interpolate conditions between monitoring events. There are a few continuous monitoring buoys presently deployed by the University of Connecticut that provide additional data and will continue to do so as long as such monitoring continues. Regarding the comment on the need to coordinate LIS monitoring, the Department and presumably all government agencies involved with the Long Island Sound Study (LISS), similarly agree and will work towards achieving this objective.

Comment: We cannot support the maximum 7-day duration period for minimum DO without a monitoring interval of not more than five days to assure that water quality violations are detected in a timely manner. A monitoring frequency consistent with

the DO duration allowance should be adopted in conjunction with the proposed standard, for the standard to have any meaning. We understand that the monitoring interval for DO is currently once every two weeks. DO levels could fall below 3.5 mg/l for up to a month without being detected as a violation. If a biweekly DO measurement detects levels below 3.5 mg/l, we assume that measurement would start the 7-day clock. The sub-3.5 mg/l level may have existed up to 13 days previous to the measurement. Two more weeks would pass before the next measurement is taken. If the second measurement shows DO below 3.5 mg/l, then technically the violation would not occur until that measurement is taken. Thus the potential time frame for a violation to go undetected would be 27 days. This is an unacceptable time frame to allow a violation to continue without being considered a violation. (SK)

Response: See prior response to comment concerning adequacy of monitoring frequency.

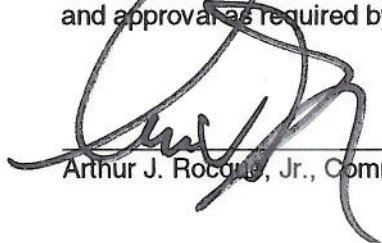
Comment: Atmospheric deposition has a significant effect on the ability of Long Island Sound to meet its dissolved oxygen criteria. With the prevailing winds in this region being westerly, the Department needs to impose, regulate or work with other jurisdictions to regulate the nitrogen and other atmospheric pollutants contributing to depressed DO in the Sound. (ISC)

Response: Agreed. EPA and the northeast States should needs to study the need for regional NOx reduction plans that go beyond ozone control and consider nitrogen deposition impacts.

Comment: It is important for the Interstate Sanitation Commission to keep abreast of what is happening in the Connecticut waters, because it does affect what the Commission might have to consider in the future regarding ISC's Water Quality Regulations for ambient waters, not only the marine waters of Long Island Sound, but the waters of the New York/New Jersey Harbor Estuary Complex as well. (ISC)

Response: The Interstate [Sanitation] Environmental Commission (IEC) will be kept informed with all matters concerning Connecticut Water Quality Standards for Long Island Sound. The Department looks forward to reviewing similar proposed Water Quality Standards revisions from both the IEC and the State of New York Department of Environmental Conservation.

Proposed Revisions: The Department's proposed Water Quality Standards, coastal dissolved oxygen criteria revisions, as amended in the above comment responses, shall be forwarded to the Environmental Protection Agency New England for review and approvals required by the Federal Clean Water Act.



Arthur J. Rocca, Jr., Commissioner

2/21/01

Date

**Addendum: Statement of Reasons for Water Quality Standards Revisions
Concerning Coastal Dissolved Oxygen Criteria
Hearing Date: April 20, 2001**

On November 30, 2000, the Environmental Protection Agency published notice in the Federal Register (65(231):71317-71321) of the adoption of the Environmental Protection Agency's *Ambient Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras*. The Connecticut Department of Environmental Protection (the Department) sought copies of the new criteria document and was able to review it when the Environmental Protection Agency added it to its Web site in January, 2001.

As noted throughout the public hearing process, the Department relied very heavily on the draft Ambient Water Quality Criteria for Dissolved Oxygen document published in January 2000. A number of comments highlighted the concern that EPA's document was draft and the final recommended criteria may be different than that proposed by the Department. In the Statement of Reasons (Revisions Concerning Coastal Dissolved Oxygen Criteria), the Department acknowledged this possibility and noted an interest to re-evaluate its proposed criteria when the final document was available. The Statement of Reasons noted this could be accomplished within 3 years to coincide with the three year tri-annual cycle in the Federal Clean Water Act for State Water Standards review and the scheduled re-assessment of the Long Island Sound Management Plan. Since the final EPA document recently became available, the Department was able to complete its review prior to the conclusion of this hearing process.

During the first two weeks of February 2001, the Department's technical staff reviewed the adopted EPA saltwater dissolved oxygen criteria document. The most important changes in EPA's adopted saltwater dissolved oxygen criteria document are:

1. EPA has revised the larval recruitment model to include other organisms. The draft document had developed the larval recruitment curve based on one species, the mud crab (*Dyspanopeus sayi*). The revision considered several genera and the final recruitment curve used the four most sensitive genera (*Morone*, *Homarus*, *Dyspanopeus*, and *Eurypanopeus*). This alone did not alter the final recruitment curve since the mud crab is still the most sensitive species evaluated. However it did lead to another change (see next item, No. 2).
2. EPA agreed with concerns that the Virginian Province represents a range of regional conditions that affect both the duration of larval development and the length of the larval recruitment season. The model was found to be most sensitive to a simultaneous decrease in larval development duration and an increase in recruitment season. The model was adjusted to reflect criteria that are protective of most species under most conditions, i.e., a conservative application to ensure protection of the most sensitive species and the most critical larval development and recruitment season conditions. According to EPA, this revised model application may in fact be overprotective in some site-specific situations. The end result was a final dissolved oxygen curve still based on the mud crab as the most sensitive species, which accounts for no greater than 5% cumulative impairment of seasonal larval recruitment, but which reduces the cumulative exposure period.

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3. EPA disagrees with other concerns that the 5% cumulative reduction in larval seasonal recruitment is too high to protect the resource, arguing that many species may be able to withstand an even greater loss without affecting juvenile recruitment appreciably. EPA also offers that the criteria document provides adequate information to allow managers to make adjustments in the 5% level, if local protection needs of sensitive species warrant a more stringent level of protection.
4. The revised document strengthens and clarifies the use of the larval recruitment dissolved oxygen curve as an appropriate risk assessment approach for developing standards under persistent oxygen conditions.

While these changes are rationalized and appear acceptable, it has come to our attention that the formula used to calculate the exposure days for the larval recruitment model is incorrect in the final criteria document. In Table 6 on page 37 of the final criteria document, the formula specifying allowable concentrations for dissolved oxygen (DO_i) should, in the denominator, have e raised to the $-0.10t_i$ power rather than to $-0.10ti$, where t_i = the exposure interval in days. Using this corrected formula slightly reduces the number of exposure days from that recommended in the Department's criteria proposal (i.e. for different incremental DO ranges described in Appendix E Table 1., 24 days reduced to 21 days, 13 days reduced to 11 days, and 7 days reduced to 5 days). Nevertheless, this more conservative approach taken by EPA in the final criteria document is still consistent with method DEP used to put forth its proposal.

With these relatively minor adjustments to the exposure criteria, the Department's recommended criteria would be compatible EPA's adopted criteria. The Department's proposal will, therefore, be modified consistent with these EPA's adopted saltwater dissolved oxygen criteria and thereby address concerns about relying upon the draft document (comments made by ISC and EPA).

Proposed Revisions: The Department's proposed Water Quality Standards, coastal dissolved oxygen criteria revisions, as amended in the above comment responses, shall be forwarded to the Environmental Protection Agency New England for review and approval as required by the Federal Clean Water Act.



Arthur J. Rocque, Jr., Commissioner

2/2/01

Date

DEFINITIONS

Coastal [and Marine] Waters

[Those waters generally subject to the rise and fall of the tide and] **As defined in [by] Section 22a-93 of the Connecticut General Statutes [as amended] and means those waters of Long Island Sound and its harbors, embayments, tidal rivers, streams and creeks, which contain a salinity concentration of at least five hundred parts per million under the low flow stream conditions as established by the commissioner.**

Nearshore

[Surface] Coastal waters of Long Island Sound that are generally less than 5 [M] meters in depth at mean low water and include embayments and harbors.

Offshore

[Surface] Coastal waters of Long Island Sound that are greater than 5 meters in depth at mean low water.

Pycnocline

A steep density gradient in an estuary caused by differences in temperature or salinity between the bottom and surface layers of water that limits mixing of the two layers.

III. SURFACE WATER CLASSIFICATIONS

COASTAL [AND MARINE SURFACE] WATERS, CLASSES & CRITERIA

CLASS SA

Parameter	Criteria [Standard]
Dissolved Oxygen	<p>Not less than 6.0 mg/l at any time in the nearshore waters of Long Island Sound, including harbors, embayments and estuarine tributaries.</p> <p>Not less than 6.0 mg/l at any time in the offshore waters of Long Island Sound above the seasonal pycnocline and throughout the Sound when no pycnocline is established.</p> <p>Not less than 3.5 mg/l for offshore waters within and below the seasonal pycnocline. Cumulative periods of dissolved oxygen exposure in the 3.5 - 4.8 mg/l range shall not exceed parameters detailed in Appendix E.</p>

CLASS SB

Parameter	Criteria [Standard]
Dissolved Oxygen	<p>Not less than 5.0 mg/l at any time in the nearshore waters of Long Island Sound, including harbors, embayments and estuarine tributaries.</p> <p>Not less than 5.0 mg/l at any time in the offshore waters of Long Island Sound above the seasonal pycnocline and throughout the Sound when no pycnocline is established.</p> <p>Not less than 3.5 mg/l for offshore waters within and below the seasonal pycnocline. Cumulative periods of dissolved oxygen exposure in the 3.5 - 4.8 mg/l range shall not exceed parameters detailed in Appendix E.</p>

Appendix E

Dissolved Oxygen (DO) Criteria for Offshore Coastal Waters

Background: Offshore Coastal DO criteria are based on the Environmental Protection Agency's *Ambient Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras*, noticed November 30, 2000 in the Federal Register (65(231):71317-71321).

Area Affected: DO criteria different from the 6.0 mg/l and 5.0 mg/l minimums for Class SA and SB offshore waters apply only in and below the pycnocline of Long Island Sound (LIS) where stratification occurs during warm, summer conditions. Offshore waters are defined as areas of LIS greater than 5m in depth at mean low water. Offshore waters above the pycnocline generally have ample DO from photosynthesis and wave-driven diffusion.

Cumulative DO exposure parameters: DO conditions in the area affected do not readily lend themselves to a single numeric criterion as is often done with toxic contaminants. Aquatic organisms are harmed based on a combination of minimum oxygen concentration and duration of the low DO excursion. A DO concentration of 4.8 mg/l would meet the chronic criteria for growth and protect estuarine organisms resident in LIS regardless of duration. If oxygen fell within a 0.5 mg/l incremental range below 4.8 mg/l (*i.e.*, between 4.3 and 4.8 mg/l), a duration of 21 days or less would meet resource protection goals. Based upon the EPA research and data, similar exposure allowances were used by the Connecticut DEP for each 0.5 mg/l increment (see Table 1). The minimum DO level that can be associated with the draft EPA DO criteria document (*i.e.* the level below which there would be no exposure period consistent with resource protection) is 2.3 mg/l. Given the environmental variability, DEP has used more protective minimum DO criteria of 3.5-3.8 mg/l with no more than 5 days exposure.

Because estuarine systems are variable, DO levels are unlikely to remain within one of the three incremental ranges presented in Table 1. Typically, DO conditions would fall through a range to a minimum and then begin to rebound depending on weather and stratification conditions. To account for this, the number of days within each incremental DO range is prorated, as follows. A decimal fraction is calculated for each range, *e.g.*, 10.5 days in the 4.3-4.8 mg/l range would produce a decimal fraction of 0.50 (10.5 days/21 days). As long as the sum of those fractions calculated for each range is less than 1.0, resource protection goals are maintained for larval recruitment.

Table 1. DO incremental ranges and duration (exposure) data to be applied to LIS in the area affected to ensure protection of larval recruitment.		
DO Range (mg/l)		No. of Days Allowed
Maximum	Minimum	
4.8	4.3	21
4.3	3.8	11
3.8	3.5	5